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PHYSICAL EXERCISE APPARATUS AND FOOTREST PLATFORM FOR USE WITH THE APPARATUS

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Physical exercise apparatus and footrest platform for use with the apparatus

The present invention relates to a device for strengthening and rehabilitating a person's muscles and is especially based on embodiments related to the principle of controlled exercise by having to balance/control instability during physical exertion. More precisely, the invention relates to a device as disclosed in the preamble of the attached independent claims.

PCT Application Publ. No. WO00/68067 describes a pedal device for physical exercise, for example, a bicycle or exercise apparatus, wherein the device comprises a first pedal that is rotatably attached to a pedal shaft which at the free end thereof can be rigidly mounted to the crank arm, and wherein the first pedal has a pedal engagement face for use in the performance of conventional exercise, and wherein the device is made having a second pedal tiltably attached to the first pedal about an axis that extends transversely through a longitudinal axis of the pedal shaft.

From what is previously known, exercise under controlled instability will have a positive health effect on a person's muscles, tendons and balance, both in the case of strength training and during rehabilitation after injury. It is important that the degree of movement of the devices which provide instability in an exercise apparatus can easily be adjusted and that this adjustment is stepless from a lockable position. This will spare a first-time user from experiencing a movement of the exercise apparatus for which he was unprepared.

The earlier solutions for instability in exercise and sports equipment have limited areas of application. The pedals described earlier will typically be suitable for bicycles and stationary exercise bicycles, and are not suitable for use in fitness apparatus such as step machines and different exercise apparatus for combined leg and arm exercises. The object of the present invention is to solve the problem of how instability can be implemented in other exercise apparatus and exercise methods than those previously known. The characteristic features of the invention are set forth in the attached independent claims. Additional embodiments of the device are set forth in the associated dependent claims. Thus, the invention comprises solutions in connection with footrests that have a tilting function and adjustment thereof, and where the footrests can be adapted to suit different exercise apparatus. There will also be described apparatus equipped with footrests which in addition to a tilting function also have a sliding function, and that the exercise apparatus have different solutions for arm

movements which include the use of poles and handles. The invention also comprises a number of solutions for manual and automatic adjustment of the tilting function of footrests and the length of the sliding function thereof.

The application will describe the invention split into three main groups:

- footrests with a tilting function and adjustment of the degree of tilt and locking mechanisms therefor, and how these are adapted to and work in conjunction with different exercise apparatus;
- exercise apparatus which provide stride and step exercises with footrests that have both a sliding movement and a tilting movement; and
- exercise apparatus which provide a simulated walking and running motion with footrests that have both a sliding movement and a tilting movement.

The invention will now be described in more detail with reference to the attached drawings:

Figs. 1a and 1b show footrests equipped with a device for tilting function.

Figs. 2a and 2c are sectional views through the adjusting mechanism for the tilting function of the footrests as indicated in Fig. 2b.

Figs. 3a and 3b show an exercise apparatus for stepping exercises in which bars have mounted thereon footrests for tilting function;

Figs. 4a and 4b show an exercise apparatus for circular leg exercises and arm movements, wherein bars have mounted thereon footrests for tilting function.

Fig. 5 shows an exercise apparatus for stepping exercises wherein bars have a tilting function.

Fig. 6 shows an exercise apparatus for circular leg exercises and arm movements, wherein bars have a tilting function.

Figs. 7a-7h show footrests with a further arrangement for adjusting the tilting function.

Figs. 8a-8c show an alternative arrangement for adjusting the tilting function of footrests.

Figs. 9a-9c show an exercise apparatus equipped with tiltable footrests, where exercises may consist of a stepping, sliding and tilting function for legs, and wherein the exercise apparatus has poles for arm movements.

Figs. 10a-10c show the exercise apparatus shown in Fig. 9, but with flexible poles.

Figs. 11a-11d show yet another variant of an exercise apparatus with tiltable footrests, and poles for arm movements.

Fig. 12 shows detail XII of the exercise apparatus shown in Fig. 11.

Figs. 13a-13d show a variant of an exercise apparatus for the performance of circular leg exercises and arm movements, wherein footrests are in operation with adjustable spring bars.
Figs. 14a-14b show yet another variant of an exercise apparatus for the performance of circular leg exercises and arm movements, wherein the footrests have a sliding function relative to movable bars.

Figs. 15a-15b show a variant of an exercise apparatus for the performance of circular leg exercises and arm movements, wherein the footrests have a curved slide path.

Figs. 16a-16f outline different forms of slide paths and tracks for footrests.

Figs. 17a and 17b are perspective views from in front and from behind (from the underside) of the exercise apparatus shown in Fig. 15, and Figs, 17c and 17d show details XVIIc and XVIId of links and adjusting mechanism.

Fig. 18 is yet another figure of the exercise apparatus shown in Figs. 15, 17a and 17b.

Figs. 19a, 19b and 19e show an exercise apparatus with an automatic adjusting mechanism of step length, and Figs. 19c and 19d show sections XIXc and XIXd.

Fig. 20 is a block diagram of elements that control the automatics of the adjusting mechanism.

Figs. 21a-21c show an exercise apparatus with handles that have a sliding movement.

Figs. 22a and 22b show an exercise apparatus with poles that are telescopic, and Fig. 22c shows section XXIIc.

Figs. 23a, 23b, 24a and 24b show a variant of the exercise apparatus shown in Fig. 9, and Fig. 23c shows section XXIIIc in Fig. 23a.

Fig. 25a is a perspective view of a variant of the exercise apparatus with a mechanism for adjusting step length shown in Fig. 19, and Fig. 25b shows section XXVb.

Fig. 26a shows an adjusting mechanism in the exercise apparatus shown in Fig. 25, and Fig. 26b shows the section XXVIb-XXVIb.

Fig. 27a is a top perspective view of the exercise apparatus shown in Fig. 25, and Fig. 27b shows a detail section XXVIIb of the footrest.

Fig. 28 shows a footrest where the individual parts for adjustment of the tilting movement are shown.

Figures 1 and 2 show a footrest consisting of a platform 1 that is configured for the positioning of a user's foot, with or without a shoe. The platform is mounted on a frame 2 which at the back edge is suspended on a shaft 4 and at the front edge is fastened to a device 6 for adjustment of a tilting movement. This tilting movement, illustrated by arrow 9, runs transverse to the longitudinal axis 7 of the platform. As can be seen from Fig. 2a, the footrests have shaft 10 in which is mounted a spring bit 12. Arranged around bit 12 is a spring catch 13. The catch can be pushed along the length of the spring bit, illustrated by arrow 15. Positioning the spring catch 13 right against the shaft 10 will prevent the shaft and thus the platform 1 from tilting. Moving the spring catch 13 from the shaft 10 and the mounting of the spring bit 12 will allow a gradual twisting of the shaft 10 and a tilting of the platform 1 to be obtained. A threaded rod 18 is in engagement with the spring catch 13. A wheel 20 is mounted axially at one of the ends of the rod 18. Upon rotation of the wheel 20, the spring catch 13 will move in one direction or the other along the spring bit 12. Thus, by rotating the wheel, a user will easily be able to adjust step by step the degree of tiltable instability of the platform. As shown in connection with Fig. 2c, the embodiment allows the adjusting wheel to be replaced by an electromotor 11, which is controlled using a switch 14 with the foot, or that a switch, or the control medium, for example a multifunctional switch (which can also serve other functions in the exercise apparatus) may be located at other points on

the exercise apparatus with a cable connection, or a wireless connection (for example, Bluetooth™), on the frame, handles or a control panel.

Figure 3 shows an exercise apparatus that is used for stepping exercises, a so-called "step" apparatus or stepper. The user will stand on step beams or bars 22, 22' and hold handles 23, 23' in order to then force the bars downwards using the force of his legs, as indicated by arrows 24, 24'. The counter-force is generated by dampers 33, 33'. Footrests 26, 26' are mounted on the bars as shown in connection with Figs. 1 and 2. The user can adjust the degree of tilting either before he/she mounts the apparatus, or once he/she is standing on the footrest platforms. The wheel used for adjustment of tilting can also be rotated using the foot. Fig. 3b indicates the position of switches 14', 14", 14"' for operation of the tilting mechanism, where control takes place either electrically by cable transmission, by wireless signal transmission, or by a mechanical solution using wires. The footrests are mounted in grooves which means that the user can adjust the platforms along the bars and thus provide a variation of the force that is necessary for movement thereof. This is illustrated by arrows 25, 25'.

Figure 4 shows an exercise apparatus on which a user can perform oval-circular movements of his feet and thus his legs and at the same time a push-and-pull exercise with his arms. The user stands on bars 28, 28' and steps downwards and backwards, which movement is then replaced by an upward and forward movement, illustrated by Fig. 4b, 29. The bars are in engagement with a wheel 35 that has adjustable resistance. The bars are also in engagement with handles 32-32' which move back and forth as illustrated by arrows 36-36'. The tilting platforms 27-27' are adjustable along bars 28-28', for example, along a groove 30 with stepwise or steplessly adjustable engagement, or in another known way. The oval-circular movement will be variable according to where the footrests are positioned along the longitudinal direction of the bars as illustrated by arrows 31, 31'.

As mentioned in connection with Fig. 1, it is conceivable that adjustment of the footrest tilting function of the platforms can be done in other ways than by using a rotatable wheel. It can be done by having an electromotor that is connected to the threaded rod, thereby replacing the rotatable wheel as shown in Figs. 1 and 2. For operation, switches 14', 14" are positioned on the exercise apparatus so as to be within easy reach of the user, for example, on handles, or on a panel 34 as shown in Fig. 4. One advantage of having a motor connected for adjustment of the extent of tilt is that the platform can be positioned in a neutral, level and fixed position when not in use. This is so that the user

will not be surprised by tilting movement when he/she first mounts the exercise apparatus, but can adjust the extent of tilt gradually as required. In connection with the platform there could be sensing devices in the form of sensors or switches that will register whether the apparatus is in use or not. When the apparatus is not in use, a sensing device will give a signal to the motor so that it actuates the platform to move into a neutral, level and fixed position.

Another mechanical solution is to replace, or connect the rotating wheel to a wire and pulley solution which will actuate the spring tightener. The other end of the wire can thus be arranged on the exercise apparatus handles 23, 23' (Fig. 3) or 32, 32' (Fig. 4) so as to be close to the user's hands. Thus, the technology used here can be taken from the technology that is used in a gear shift on an ordinary bicycle. The content of this paragraph is, however, not illustrated in the figure, but should be so well known that the skilled person will immediately see how it can be implemented.

Modern and advanced exercise apparatus will have a panel with a display for various items of information about the apparatus and the performance of the exercise. This may be information about time, resistance, performance, pulse, stamina, apparatus settings, memory of earlier achievements and so on. The exercise apparatus may also contain technology for processing data and exchanging the data with various exercise programs and competitors who use similar exercise apparatus and systems.

The exercise apparatus as shown in connection with Figures 3 and 4 can also be made so that the bars on which the user stands have a direct suspension that is adjustably tiltable as a replacement for the footrests described above. In connection with Fig. 5, links 40, 40' which have adjustable torsional resistance can be fastened to bars 42, 42' to be able to tilt the bars transverse to the centre axis 44, 44' of the bars. The technical solution used here may be like that shown in connection with Figs. 1 and 2, but alternatively a torsion bar solution may be used which by an adjustment of its degree of torsion can adjust the extent of tilt. Alternatively, other known technical solutions may be used and will therefore not be described in more detail.

In connection with Fig. 6, bars 46, 46' can be connected to a spinning wheel 50 and arms 52, 52' can be connected in links 53, 53' and 54, 54', which renders the bars 46, 46' adjustable and tiltable relative to the longitudinal groove 55 of the bars. The bars may have a suspension similar to that shown in connection with the footrest illustrated in

Figs. 1-2, where one of the links 53, 53' has a shaft and an adjusting mechanism at the other link 54, 54'.

As mentioned in connection with Fig. 5, a skilled person will, in the light of what has been described, be able to use various technical solutions in order to obtain the tilting effect that the present invention exhibits.

Movement of footrests as shown in, *inter alia*, Fig. 1 will, within the scope of the invention, have various technical solutions. Fig. 7 shows a further solution for control and adjustment of the movement of footrest 60. Movement of the platform is indicated by arrow 65. The platform (upper part of the footrest) 61 is mounted on a frame 62 and is movable about shafts 63 and 64, i.e., about axis 69. Located between the platform and the frame are the devices that adjust the degree of tilt of the platform. This is clear from Figs, 7c and 7d. Fastened to the platform is a block 66 which at one end has a v-profile 67. Another block 68 has an inverse profile which rests under pressure against a block 66. The block 68 exerts a pressure against block 66 that is generated by a spring 70. The spring 70 is tightened in that a cylinder 71 exerts pressure against the spring with the aid of a rotating wheel 72. The rotating wheel 72 has an elliptical form. Rotation of the wheel 72 will actuate the cylinder 71 to tighten or slacken the spring 70, which in turn provides a pressure from the block 68 against the block 66 for adjustment of the degree of movement of the platform. Fig. 7f shows the wheel 72 in a position where a spring exerts least force against block 68. On rotation of the wheel in one direction or the other as indicated by arrow 75, for example towards point 74 on the wheel, the pressure from block 68 against the profile in block 66 will increase. It should be understood that the frame of the footrests can be adapted so that it can be fastened to different variants of exercise apparatus.

Fig. 8 shows another solution for adjustment of the degree of tilt of the footrest platform as described, *inter alia*, in connection with Fig. 1 and Fig. 7. Fig. 8 shows a frame 80 where platform 61 as shown in Fig. 7 is indicated in the broken line 81. The platform is tiltable about shaft 82 and will rest against and be movable on bearings 85, 86. To be able to adjust the movement the platform will have about shaft 82, blocks 88-91 are provided between the platform 61 and the frame 80. The blocks will, because of their substance, determine the degree to which the platform can be moved. If a rigid material, e.g., metal or hard plastic is used, the platform will be allowed to tilt. A less rigid material in the blocks will provide the platform with a movability. The blocks are made so as to be easily replaceable. Thus, the possibility exists of being able to adjust

the degree of tilting movement of the platform by having replaceable blocks of varying rigidity.
In substitution for blocks of a rigid substance, air-filled chambers 96, 96' could be arranged between the tilting platform and frame as shown in Fig. 7c. The degree of possible tilt of the platforms could then be adjusted by adjusting the air pressure in the chambers.

The reference numerals 92, 95 indicate wheels fastened to the frame which render the footrests slidable and adjustable to the fitness apparatus on which they are to be used.

The following will describe an exercise apparatus that uses the footrests and solutions for instability as described above. Figure 9 shows an exercise apparatus wherein footrests 96, 97 have a tilting function transverse to the longitudinal direction of the platform and the bars on which the footrests are mounted. The footrests may preferably have a design as described above. The footrests are slidably mounted on bars 98, 99. Mounted on the footrest frame are wheels (see Fig. 8) that run in tracks 101, 102 that are a part of the bars 98-99. At one end, the bars are movably fastened to frame 100 by swivel joint 110, 111. This renders the step arms movable as indicated by arrow 112. The movement is limited by articulated arms or guides 114, 115 which at one point of attachment are attached to the underside of the bars 98, 99 and at another point of attachment are movably fastened via shaft 117 to the frame. The degree of movement of the shaft is limited by a cylinder 118. This is a damper/resistance cylinder of an oil or gas type. This provides inertia of movement of the bars 98, 99. Adjustment of the movement of the cylinder is effected by screw head 119 and gives a variation of the resistance that must be overcome when using the exercise apparatus. Movement of the bars is transmitted to the poles 120, 121 by means of articulated arms 122, 123. A downward movement of one bar will result in the associated pole moving forwards and in the opposite direction when the bars have an upward movement, indicated by arrow 124. As mentioned, the footrests are movable along said bars in tracks. Articulated arms 128, 129 are mounted from frame 100 to each of the footrests. When the bars 98, 99 move, the articulated arms 128, 129 will guide the footrests along the tracks as indicated by arrow 126.

The exercise apparatus described here in connection with Fig. 9 thus has the following mode of operation: a person stands on the footrests and holds onto both poles and with one leg exerts downwards force which results in the footrest and its bar moving downwards and in that the footrests in addition move backwards whilst the associated

pole on the same side moves forwards. When maximum downward pressure has been reached on one of the footrests, the person transfers force to the other footrest. The result is that an alternating movement between arms and legs of the person using the apparatus is achieved. The person must in addition hold each platform in balance, but as described earlier, this movement is adjustable from being fixed to having a tilting function.

Figures 10a-10c show an additional function for fitness apparatus 130 as shown and described in connection with Fig. 9. The solution is meant to provide a function for training the arms of the person using the machine. Handles or poles 131, 132 can be set to move sideways in towards the apparatus or in the opposite direction, as indicated by arrows 134, 135, that is to say, transverse to the primary direction of movement of the various parts of the apparatus.

The handles can be used for exercise either when the person is standing on the footrests of the apparatus or when the person is standing on the floor. Here, spring poles 136, 137 are shown which consist of an elastically yielding material such as metal used in torsion bars, or an assembly of parts, e.g., such as a spring bank. The handles as shown here can be set in steps 138 and locked by a spring pin 139. A person skilled in the art will appreciate that the actual technical solution can be achieved in a number of ways, and the solution shown here should not be understood as being limiting for the invention. The elastically yielding part of the pole may be the lowermost part of the pole 140 or higher up as indicated by 140'. The design is such that the spring pole 136, 137 cannot be stretched towards the person exercising, i.e., in the longitudinal direction of the apparatus, but will follow the primary function of the apparatus as described earlier.

Fig. 11 shows yet another variant of the exercise apparatus shown and described in connection with Figures 9 and 10. The footrests 150 and 151 are tiltable sideways relative to a frame or carriage 152 and 153, each of which is slidable in respective tracks 154 and 155 on bars 156 and 157. A central frame 158 has tracks 159 and 159' with which the carriages 152 and 153 are in connection. The tracks have a curved shape. The frame has a height x, see reference 165, which gives the track a backward and downward path. When the bars are set in motion, as indicated by arrow 162, the platforms will move in the trackway 160 and along the bars as indicated by arrows 163 and 164. Resistance cylinders 168 and 169 that are fastened between frame part 170 and the bottom of the bars provide resistance on movement of the bars. Movement of the

bars is also controlled by tilting part 172. As can be seen from Fig. 12, this tilting part is mounted on the central frame 158 and is tiltable about a shaft 173. Mounted at each end of the tilting part are articulated arms or guides 174 and 175 that are movably articulated to the underside of the bars. The length of the articulated arms can be adjusted by a screw cylinder 176 and 177, which will affect the movement of the bars. The tilting part ensures that when one of the bars is lowered the other will be raised. Resistance in the movement of the different components of the exercise apparatus is adjusted by a tensioning mechanism in connection with tilting part 172. A friction disc or braking element 180 exerts pressure on the tilting part and is adjusted by screw part 181. Handles or poles 166 and 167 are articulatedly connected to the bars as shown in connection with Fig. 9.

This exercise apparatus will give a longer step length than is possible with the exercise apparatus shown in connection with Fig. 9 and will give the same or longer step length than is possible for elliptical trainers with larger rotating wheels and crank.

An exercise apparatus that gives an elliptical movement of the legs of the person exercising has been described above, see Figs. 4 and 6. Another embodiment as indicated by the reference numeral 200 in connection with the footrests is shown in Fig. 13. Here, each footrest 201, 201' has a shaft 204, 205 in respectively the front edge and back edge and that is torsionally secured to spring member 206, 207. The spring members 206, 207 give the footrests a more cushioned movement than if they were secured to a fixed bar. Fig. 13c shows a variant where spring members 210 and 211 are constructed "telescopically". This allows the hardness of the springs to be set. Fig. 13d indicates a method where a through-going tensioning screw 212 can be moved and tightened to set the length of the spring as indicated by arrow 213, in order to adjust the degree of spring cushioning, although this solution as shown should not be understood as limiting for the invention.

In connection with exercise apparatus that give a circular movement of the feet and legs of a user, referred to as "elliptical" in this application, the rotating wheel or crank to which bars for the footrests are attached will determine the length and height of the elliptical movement the user endeavours to achieve during exercise. The "elliptical" exercise apparatus on the market today are dependent on the size of the rotating wheel and crank with the result that these exercise apparatus are often very large. However, the height displacement of the foot platforms does not seem to be the main reason for the size of the rotating wheel, but rather its horizontal movement. The rotating wheel of

the elliptical exercise apparatus on the market today is often 50 cm in diameter in order to give a movement of the bars which in turn gives step lengths from 40-50 cm. The present invention seeks to obtain an elliptical exercise apparatus that can be more compact than today's solutions, but still give at least as good an exercise experience and effect. Fig. 14 shows an exercise apparatus that does not require a particularly large rotating wheel or crank, but which will still provide the apparatus footrests with a desired step length in a horizontal movement.

The exercise apparatus shown in Fig. 14 consists of a frame 230 which has a flywheel 231 with associated crank 232. The crank is movably connected to bars 233, 234 which in turn are mounted on movable articulated arms 236 and 237. The articulated arms are mounted on shaft 238 which runs through the forward part 230' of the frame. The footrests 240, 241 are tiltably mounted on carriages 242 and 243 which in turn are arranged slidably on the bars. The footrests are described in connection with, *inter alia*, Figures 1, 7 and 8 and also have a movement relative to the bars as shown in connection with Fig. 9. The movement of the platforms along the bars is controlled through use of articulated arms 236, 237 which have further associated articulated arms 246, 247 articulatedly connected to the footrest carriages. The length of these articulated arms determines the displacement of the carriage along the bars. If the length indicated by 236', 237' is adjusted, the carriages and thus the footrests will change this displacement. This length 236', 237' can be made adjustable; however, this is not shown in the figure, but will be easy for the skilled person to implement. The exercise apparatus also has handles or poles 250, 251 which are movably connected to respective bars 233, 234 by links 252, 253. The poles 250, 251 are preferably throughgoingly movable in these links. The poles are movably suspended through shaft 254 in the frame where the position of the shaft in the vertical direction 255 will determine the displacement of the poles independent of the movement the bars give. This can be done adjustably, and an embodiment is shown in connection with Fig. 17.

The figures do not show how resistance in movement of the exercise apparatus components is solved. However, this is known from elliptical exercise apparatus on the market today. Here, various forms of brake technology of the flywheel are used such as slip belts, indicated by 256, or brake pads or a magnetic brake device 257.

The slide path in which the footrests run on the exercise apparatus shown in Figs. 9 and 14 is completely linear. To obtain a movement of the footrests that is most similar to the movement of the foot in a walking or running situation, ordinary elliptical fitness

apparatus have fairly large wheel/crank solutions. Exercise apparatus as shown in Fig. 14 and Fig. 15 have a limited wheel/crank which in a practical embodiment is no larger than about 25 cm. This gives a limited horizontal movement, but with the sliding function of the footrests the desired step length will still be obtained. The vertical movement and the angle of the footrests will still be limited by a wheel/crank of this size. In order to obtain a varied movement of the footrests, it will be understood that the invention comprises a solution where the slide paths of the footrests have a curved shape.

Fig. 15 shows an exercise apparatus like the exercise apparatus shown and described in connection with Fig. 14. Footrests 260, 261, including associated carriages, run along respective bars 262, 263 in tracks 264, 265. Fig. 15a shows footrest 260 in the foremost position, whilst Fig. 15b shows footrest 260 in the rearmost position. As can be seen in the figure, the angle of the footrest will change from the rearmost position to the foremost position. The actual curvature of the tracks and bars as shown in the figure should not be understood as limiting for the invention. The track itself may be shaped as indicated in Figs. 16a-16f without this being understood as limiting for the invention. Different curvatures of the tracks will give the footrests a movement and an angling for desired operation of the exercise apparatus according to the invention. Articulated arms 270-273 guide the footrests along the tracks 264, 265 on the bars. The length of the articulated arms in combination with the size of the wheel/crank 266 dictates the length of the movement of the platform which in its turn dictates the step length 267 of the exercise apparatus. Variation of the length of the articulated arms 270-273 will thus give a variation in the step length. An adjustment of the step length is possible for this exercise apparatus by changing the working point 274, 275 between the articulated arms 270-273. This can be seen in Figs. 17c and 17d. In this figure, tracks 278 and 279 that are attached to the articulated arms 270 and 271 are visible. The end of the articulated arms 272 and 273 is secured to the tracks 278, 279 via bolts 280, 281 which are slidable in the tracks 278, 279 and which can be locked in desired positions along the tracks for desired step length, e.g., by using a locking handle, such as handle 281'. As can be seen from Fig. 17, the exercise apparatus has grip poles 282, 283 which are movably connected to respective bars via links 284 and 285. The poles 282, 283 are throughgoingly movable in these links. The poles are movably mounted through shaft 287 in the frame 290 as can be seen clearly in Fig. 18. The position of the shaft 287 in the vertical direction 288 is adjusted by a locking screw in an adjusting mechanism 289, as indicated in Fig. 18. The height adjustment will determine the extent of movement of

the poles as a result of the distance between links 284, 285 and the position of the shaft 287 on the frame 290.

It should be stressed that exercise apparatus as shown in connection with Figs. 9 and 11, also within the scope of the invention, may have a slide path and tracks which are not linear, but which may, for example, have a curvature as indicated in Fig. 15 or Fig. 16. Although these apparatus do not have bars connected to a rotating mechanical device, a curved slide path will give the footrests a larger variation of angle with a subsequent larger movability for the user in use.

In connection with exercise apparatus which have footrests with a sliding function as shown, *inter alia*, in connection with Figures 9, 11, 14 and 15, a further function will now be described with reference to Figure 19. These apparatus have a fixed step length irrespective of the exercise speed. When a person exercises moderately, the step length will be like a step length at walking speed. However, the step length will normally be greater at running speed. The step length for the exercise apparatus shown in Fig. 15 is as described adjustable. However, the adjustment must be made before an exercise session begins and cannot be adjusted as the speed of the person exercising increases. The exercise apparatus shown in Fig. 19 is very similar to that shown in Figs. 15-18, apart from a mechanism that adjusts the step length according to the rotational speed of the flywheel/crank. Fig. 19a shows an exercise apparatus with frame 300, flywheel 301 with crank, to which bars 302, 303 are secured. The bars 302, 303 have tracks or grooves 304, 305 in which the footrests with associated carriages can move. Movably attached to the bars 302, 303 are poles/handles 308 and 309 which on movement of said bars are given a tilting movement as indicated by arrow 310. Connected to the platforms are articulated arms 312, 313, 314 and 315 which draw the footrests along the bars during use of the exercise apparatus. The articulated arms 314, 315 move slidably through guides 316, 317 fastened to the bars 302, 303. The distance between the points of suspension 318, 319 of articulated arms 314 and 315 and the respective guides 316, 317 determines the length the footrests can move in the grooves on the bars and thus the step length as indicated by the reference numeral 320 and as explained in connection with Fig. 15.

As mentioned above, this exercise apparatus has a stepless adjustment of the step length. Moving the points of suspension at 318, 319 as indicated by arrow 320 will affect the degree of movement of the bars and the footrests connected thereto. This can be done by the user manually, for example, using a push/screw device, or by using a

servo/motor or a hydraulic system. In connection with Fig. 19c, a system will be described which automatically sets the step length for the exercise apparatus, although this exemplary embodiment should not be regarded as limiting for the invention.

The system described in connection with Fig. 19 will allow stepless adjustment of the step length as desired by a user, or according to the speed of the wheel/crank 301 with associated bars, bars 302, 303, articulated arms 312-315 and poles 308, 309. Articulated arms 314, 315 are fastened to a carriage 322 which runs along a linear guide 323 with the aid of a threaded rod 324 which is operated by a motor 325. The end positions are monitored by end switches or proximity switches 326 and 327. These switches may be of the inductive sensor type, mechanical switch type or other type which will be known to the skilled person, although the type of switch should not be regarded as limiting for the invention. The position of the carriage is given by counting pulses given on rotation of a threaded rod 324 which has a marker pin 321 of, for example, steel, where a proximity switch (counter) 328 is arranged to count the number of rotations of pin 321. The rotational speed of the wheel 301 is measured by a sensing device, in this case the revolution sensor 329. The position of the carriage 322 is calculated as a function of the speed of the rotating wheel.

The following is an example of how this may work. It is assumed that the wheel/crank has a diameter of about 300 mm, displacement of the carriage along the threaded rod is about 165 mm and the step length is variable between about 300 mm and 500 mm as limited by the length of the bars. The pitch of the threaded rod is equal to 1.5 mm per revolution of the wheel/crank which gives one pulse per 0.75 mm, as the threaded rod 324 has the throughgoing steel pin 321 which the proximity counter 328 measures. It is assumed that there is a desire that a speed of the wheel/crank of 60 rpm should give a step length of 400 mm. This means that the carriage will have to be about 100 mm from the switch 326. This is achieved in that the motor 325 is activated and operates the wheel/crank until about 130 pulses have been measured by the counter 328. The ratio of step length to speed is regulated through a proportional integral derivative (PID) controller 330.

As outlined in Fig. 20, a microprocessor 332 must be included in the system as described for the calculation and monitoring of the signals generated by pulse, position and speed sensors. The reference numeral 334 refers to a device for manual adjustment of step length. If a user does not want the step length to be adjusted automatically according to speed, it is conceivable that this function can be disconnected and that the

user is able to adjust the step length himself, for example, on an associated panel of switches or touch screen as indicated by 335 in Fig. 19e.

As mentioned, the technology for setting the step length can be provided in many ways. For example, a sliding potentiometer could be used to measure the position of the carriage. Optics can be used for measuring positions and rotation together with speed calculation. Electromagnetic devices may also be used for measuring speed of the flywheel or the crank. For movement of bars for adjusting step length, an alternative solution may be to use hydraulics instead of electronic motor technology.

The handles or poles that are described and attached to the apparatus in question are of more or less prior art. They have a tilting movement about a shaft where the handles describe a concave curve that runs to and from the person using the exercise apparatus. See, for example, Fig. 19a. However, this movement is not natural for a person running or cross-country skiing. The following description in connection with Figs. 21a-21c shows an exercise apparatus with handles which seek to provide as natural a movement as possible of the arms of a person working out using the exercise apparatus.

A natural arm movement for a person running or cross-country skiing describes something close to a curve as indicated by the arrow 351 in Fig. 21a. This is obtained in that handles 354, 355 run in curved tracks 356, 357 that are fastened to an upward projecting part of the exercise apparatus frame 360. The handles are movably fastened to ends of articulated arms 362 and 363 which at the other ends 364, 365 of the bars' articulated arms run in tracks 366 and 367. This can be seen most clearly in Fig. 21c. The movement of the handles is generated by the footrests 352 and 353 being set in motion. The movement and design of the exercise apparatus footrests are the same as described in connection with Fig. 19. The sliding movement of the footrests is transmitted to the handles via articulated arms and wires 368, 369 arranged on either side of the frame as indicated by Fig. 21a. The ends 364, 365 of the articulated arms are fastened to wires which run around the wheels 372-379. A slider 380 that runs in track 382 is also fastened to wire 368. Although only slider 380 and track 382 can be seen in the figures, there is a similar slider and track on the opposite side of the apparatus frame. Movably attached to the guides are articulated arms 384, 385 (hidden) which at the other end are mounted movably in links 386, 387 (hidden). These links join together bars for movement of the footrests as, *inter alia*, shown and described in connection with Fig. 19. On movement of the footrests, the articulated arms such as 384, 385 will move sliders 382 and 383 which pull the wires and which in turn pull the

articulated arms 362 and 363 along the tracks 366 and 367. These articulated arms will in turn actuate the handles so that they move in the tracks 356 and 357. The shape of the tracks determines the movement of the handles. As can be seen in particular from Fig. 21a, a curved shape of the tracks will give the handles a curved movement for the user. A straight shape of the tracks will be a correspondingly straight movement of the handles.

Fig. 22 shows an alternative design of the handles or the poles for the exercise apparatus as shown and described in connection with Figs. 19 and 21. The poles 390 and 391 have a telescopic construction where the upper parts, i.e., grip portions, 392 and 393 slide into the lower parts 394 and 395. The grip portions have pins 396 and 397 which, through openings 398 and 399 in the lower pole parts, run in tracks 402 and 403 that are fastened to the frame 401. When the poles are moved back and forth, as indicated by arrow 400, the grip portions will be pushed telescopically relative to the lower parts as a result of the movement of the pins in the tracks. Wheels will be arranged on the pins which will give a smooth movement in the tracks. The tracks have a curved shape which means that the upper part of the poles and thus the grip portions have a downward curved movement in the direction of the user. Thus, the shape of the tracks determines the movement of the poles, as illustrated by arrow 400. By comparison, a straight track will give a straight movement path.

In connection with an exercise apparatus as shown in Figs. 9-12, another variant will now be described in connection with Figs. 23 and 24. The exercise apparatus has two footrests 412 and 413, preferably of a tiltable type, as for instance shown in Figs. 1 and 7-8. These rest on tracks that are mounted on bars 414 and 415. The bars are mounted to be tiltable relative to the frame 416. Articulated arms 418 and 419 are mounted from the frame to the bottom of each footrest. These guide the footrests back and forth along the tracks when the bars are tilted, as shown in previously mentioned figures. The embodiment is very similar to that previously shown, but the present embodiment has no adjustment of resistance. The resistance is provided by two dampers 420 and 421, mounted between each bar and the frame. The dampers must thus contain the right resistance when mounted, or be of an adjustable type. Between the bars that are torsionally mounted on the frame, there is a rod 422 transverse to the direction of the bars. The rod 422 is in contact with each of the bars via pins 424 and 425. When one of the bars, for example, the bar 414 is set in motion, the rod 422 will turn to force the other bar 415 in the opposite direction of bar 414. The exercise apparatus has handles or poles 426 and 427 that are tiltably fastened to the bottom of the frame. The

movement of the bars is transmitted to the poles via articulated arms 428 and 429 which are hinged to the bars and to the poles. The poles consist of two parts and are telescopically interconnected for adjustment of their length. The reference numeral 430 indicates a display for the apparatus which, connected to sensing devices, will be able to count the number of movements made and give a user, for example, times and energy consumption in the course of an exercise session.

Figs. 25-27 will now be described. The solution of the exercise apparatus shown here is a variant of that shown in connection with Fig. 19. The exercise apparatus consists of a frame 450 which has a wheel or crank 451 that is connected to bars 452, 453 which support footrests 456 and 457. The bars are curved and have tracks or grooves 455 in which the footrests run. The bars 452, 453 are hinged to handles 458, 459 by links 462 and 463. The handles are tiltably mounted on an upwardly projecting part of the frame by links 464 and 465. Articulated arms 466 and 467 are fastened to the footrests 456, 457 and these in turn are hinged to articulated arms 468 and 469. The articulated arms 468 and 469 run through guides 472 and 473 and are fastened to shaft 474. The shaft runs in grooves and guides 476, 477 in the upward projecting part of the frame which is hollow and tubular. The articulated arms 466-469 control the movement of the footrests along the bars. The position of the articulated arms as shown in Figs. 25-27 gives the footrests a maximum displacement along the bars. Displacement of the articulated arms 468 and 469 upwards in grooves 476 and 477, as indicated by arrow 478, shortens the slide path of the footrests along the bars. Shaft 474 is in engagement with a threaded rod 479 that is connected to a motor 480 and which together are located inside the tubular frame. On actuation of the motor, the shaft will be forced by the threaded rod 479 along the grooves in the frame and moved by the articulated arms which in turn control the freedom of movement of the footrests along the bars. As shown in Fig. 19 there are sensing devices and/or switches associated with the system along the grooves 476 and 477 to stop the motor in the end positions of the shaft, and to inform the user of its position. Like the apparatus shown and described in connection with, *inter alia*, Fig. 19, this exercise apparatus will have a screen and a panel 482 for providing information to the user and for control of the apparatus. The motor and sensing devices will via a central processing unit (CPU) related hardware and software be connected to the screen and, if the screen is not a touch screen, also to a panel. The exercise apparatus thus offers the user the possibility of adjusting the step length during use and whilst the user is standing on the footrests. The apparatus also has means for resistance and adjustment thereof. This is done by using prior art where a flywheel 485 is connected to a wheel 486 via a belt 487. The flywheel is of metal and can be actuated by an electromagnet

488, where a variation of the magnetic field which can be obtained here will give desired resistance of the flywheel and thus the crank that a user must work against via stepping exercises on the footrests and arm movements of the handles. The user panel will, with the aid of known means, be connected to the electromagnet and thus give the user a simple way of adjusting exercise resistance.

An exercise apparatus as shown in connection with Figs. 25-27 is shown with footrests which in addition will be described in more detail with reference to Fig. 28. In connection with Figs. 1-8 there are shown and described footrests with a tilting function of an upper platform and various techniques for adjusting and locking this function. Figs. 27 and 28 show a further variant wherein the footrest consists of a platform 490 which at each end parallel to its longitudinal direction has shafts 491, 492. Two frame parts 493, 494 are mounted movably on the shafts 491, 491 at each end of the platform. The frame parts 493, 494 have wheels 495, 495' which in turn run in tracks on the exercise apparatus bars. Thus, when the footrests are mounted on the bars, the platform will be tiltable transverse to the longitudinal direction of the platform where a bolt 496 runs in a groove 497 on the platform that limits the movement. This solution of the footrest advantageously has a locking mechanism consisting of a spring-loaded locking bolt 498 which in one position is in engagement with the platform, as shown in Fig. 27b, but which when lever 500 is turned as indicated by arrow 499 will force the locking bolt 498 out of engagement with the platform.

Fig. 25 shows positioned above the user panel a fan 502 that is mounted so it can turn in a bracket 503. The fan can be turned relative to the bracket as indicated by arrow 504, and also the bracket is movable relative to the exercise apparatus as indicated by arrow 505. The fan is in a known manner connected to the exercise apparatus and the user panel and gives the user a further service that can be used during an exercise session.